WATER MANAGEMENT IN ALBERTA

CHALLENGES FOR THE FUTURE

BACKGROUND PAPER

VOLUME 5

WATER RESOURCES PLANNING

Alberta
ENVIRONMENT

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SUMMARY

VOLUME 5: WATER RESOURCES PLANNING

Planning is an important continuing process in Alberta to ensure sound water management. Volume five examines four aspects of planning: water resources planning, instream flow needs, water quality/quantity relationship, and lake management.

CHAPTER 1: WATER RESOURCES PLANNING

Water resources planning is the most effective means for managing water and sustaining the aquatic ecosystem on a provincial, river-basin, regional, or site-specific basis.

Early issues in water resources planning were often related to economic priorities; that is, how could the water resource be developed to yield the best economic benefit. During the '60s and '70s, environmental needs became more important as competition for an increasingly scarce resource rose. Planning developed multiple objectives where recreation, fisheries, agricultural and municipal water supply, and hydro-electric uses could be considered. Water quality issues in the 1980s became even more important to water resources planning. This development led in the 1990s to a "sustainable development" viewpoint.

As the issues in planning have changed, so has the desire for public involvement. Water resource planning has responded by expanding the public's opportunities. Examples include the use of public meetings and advisory committees.

Water resource planning is often part of a larger process that can include other provincial departments or levels of government. Planning programs also play a role in environmental impact assessments (EIAs).

Current legislation does not address formal water resources planning. The importance of planning in modern water resource management suggests that it may deserve a more significant place in water resource policy and legislation. Formal water resource planning with an approvals and an amending process could provide a stronger legal basis for planning.

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CHAPTER 2: INSTREAM FLOW NEEDS

Instream Flow Needs are the stream flows required to provide for uses that depend directly or indirectly on water flowing in a stream. Some examples of these uses include a habitat for fish, recreational uses, or maintenance and recharge of riparian water tables. Instream uses are concerned not only with the quantity of stream flow but also the quality of the water.

Traditionally, water law and policy focussed on managing rivers and streams to meet the needs of uses that withdraw water such as irrigation. Instream flow needs have been less clearly understood, not well defined, and often not adequately provided for. As our rivers and streams have become more heavily used, however, the needs of instream uses are more apparent. Measures have been introduced to establish a better balance between withdrawal and instream uses.

Different methodologies may be used in an analytical process to determine insteam flow needs. This process defines the flow that must exist to provide the preferred and bare survival conditions for specific uses. Instream flow needs are frequently used as the basis for a water management plan for a river.

Some of the difficulties in establishing instream flow needs include a lack of information required to define the needs of some uses, limited resources for collecting data and undertaking the research and analysis, and difficulties in effectively involving special interest groups and the public. Although the background paper discusses other issues, the most prominent is the question of how to protect established instream flows on an equal basis with licensed uses.

CHAPTER 3: WATER QUALITY/QUANTITY RELATIONSHIP

Water resources planning and management must consider both the quantity and quality of water available for use. Alberta Environment has developed or adapted water quantity and quality computer simulation models for water management planning and for assessing impacts of development proposals in Alberta.

Water quantity and quality are interrelated in both streams and lakes. Streams flow rates and water quality conditions are constantly changing. For example, during spring runoff, streams have greater volume with reduced concentrations of dissolved salts. Late summer to winter includes a higher proportion of groundwater and higher concentrations of dissolved salts. Outflow and inflow as well as evaporation affects lakes. During the summer, the water levels decrease while the total mass of dissolved solids in the lake remains the same.

The ***Water Resources Act*** provides the legislative authority for water quantity while the ***Clean Water Act*** (to be replaced by the new ***Environmental Protection and Enhancement Act***) is the primary legislative authority for the prevention and control of surface and groundwater pollution. Consideration needs to be given to the role of water quality and quantity issues in environmental impact assessments (EIAs) and other planning activities.

CHAPTER 4: LAKE MANAGEMENT

Alberta has a wide diversity of lakes that provide for many uses and support a variety of aquatic plants, fish, and wildlife. The goal of lake management is to ensure that the experience of enjoying a lake will be preserved for future generations.

Water levels in Alberta lakes are constantly fluctuating. Most changes are natural and result in a healthy ecosystem. Water quantity also affects the quality. The term water quality encompasses negative aesthetic qualities such as weed and algal growth, clarity and odour, as well as human health concerns such as the presence of fecal coliform bacteria.

Humans affect lakes in a variety of ways from waterskiing and fishing to being responsible for improper sewage disposal. Albertans make extensive use of the lakes, and this use is expected to increase. Sound lake management will be crucial.

There are two forms of lake management: indirect and active. Indirect lake management activities are controls used to limit human impact on lakes. Active lake management involves actions that directly affect or alter a lake to meet some need.

Such activities control water levels and/or "enhance" the water quality of a lake. The background paper raises the question of balancing the two forms of lake management.

The planning of land use activities around lakes is not undertaken in a comprehensive fashion. Some believe that Alberta Environment should be given some responsibility and authority to protect lake water from the various land use activities, especially sewage disposal practices. Options for land use planning around lakes is another area for consideration. The background paper explores these issues further.

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WATER RESOURCES PLANNING

INTRODUCTION

What is Water Resources Planning?

Water resources planning is the development of plans that achieve the long-term protection, improvement, and wise use of water on a provincial, river basin, regional or site-specific basis.

A plan for a particular river basin may be as broad as developing objectives for maintaining good water quality and instream flow needs, policies regarding industrial effluent discharges and water re-use, and guidelines for irrigation expansion. Alternatively, it can specify rates of drainage development in headwaters of smaller basins to control flooding in downstream areas.

Water resource issues vary widely in Alberta and are dependent on location, climatic zones, hydrology and the nature of human activities. Although the issues can vary widely from basin to basin, a similar approach is used in the water resource planning processes across Alberta. Plan development can be technically complex and requires extensive public involvement.

Water resource issues also change in relative importance with the passage of time. The issues of the 1980s may not be the issues of the 1990s. Due mainly to this process of changing issues and changing values, planning has been a permanent and continuing process in Alberta.

Why is Planning Important?

A wide range of competing demands are being made daily on Alberta's water resources by municipalities, agriculture, industry, recreation, fish and wildlife, and downstream jurisdictions. Planning is the most effective means for managing these often competing demands efficiently across basins and over the long term, while ensuring that aquatic ecosystem integrity is sustained. It provides a mechanism for the organized, balanced resolution of water resource allocation conflicts and identification of water resource management opportunities. Solutions to and prevention of long-term, cumulative impacts on the environment can be evaluated effectively when river basins are examined as a single catchment unit through a river basin planning process. In short, wise water management can not proceed without a planning step.

Evolution of Water Resources Planning

Water resources planning in North America has gone through a number of beneficial evolutionary changes since the mid 1930's when the U.S. government set up the Tennessee Valley Authority to manage flood control and power development on a catchment basis. In the 1950s, Ontario's Conservation Authorities were set up as local authorities, working on a basin or catchment basis to deal with flooding, soil erosion and other land use issues. This approach is still functioning well.

Working on a larger scale, River Basin Commissions were set up in the U.S.A. in the 1960s to co-ordinate water resource and land use management issues, sometimes across state boundaries. Early failures in this system of

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river basin commissions relate to "biting off more than could be chewed" in highway and land use development controls meant to protect water resources.

More recently, the passage of the ***Canada Water Act*** in 1970 led to a number of federal-provincial river basin studies such as the Okanagan, St. Johns and, most recently, the Peace Athabasca Slave study in northern Alberta and southern N.W.T. These studies typically addressed both water quality and quantity issues. They resulted in recommendations on a wide range of water matters to be adopted by appropriate federal or provincial departments.

Water resource planners across North America have had both successes and failures in addressing the major water issues in a broad context, resolving water allocation conflicts in a balanced way, and using the best affordable science and technology. What has changed since the early 1970s are the scope and depth of the issues, the rising levels of public interest in participating in this interdisciplinary work and consequent rising demands on available technologies, particularly computers.

The Changing Issues

The early issues in water resources planning were often related to economic priorities, that is, how could the water resource best be developed to yield best economic benefit in such areas as hydroelectric power generation and storage for irrigation. Water supplies were often abundant with available supplies easily meeting competing demands. A subsequent phase in the 60s and 70s involved a necessary shift to multiple objective planning, whereby recreation, fisheries, agricultural and municipal water supply and hydro-electric problems had to be looked at together because of rising levels of competition for the increasingly scarce resource. During this stage, environmental needs, often simply equated to fish needs, were treated as "just another" user of water with a hard-to-define entitlement. Environmental needs were sometimes not fully met.

In the 1980s water quality issues became an increasingly important part of water resources planning, ranking equal to or higher than such things as fisheries needs. This development has led in the 1990s to a "sustainable development" viewpoint increasingly noted in the media, and having its roots in the Bruntland Commission. This approach gives a priority to ensuring "environmental sustainability" to all parts of a water resources plan. Viewed by many as a positive move, there are uncertainties as to how this approach will affect water resource planning.

Public Involvement

Most major government policy developments now routinely undergo public discussion. In particular, environmental issues have become increasingly important to many members of the public. Various special interest groups with a primary or a major interest in water issues have developed. Water resource planning has responded by expanding the number of ways in which the general public may be involved . Examples include the use of public meetings and public advisory committees. Hearings were held as a part of the South Saskatchewan River Basin planning program by the Alberta Water Resources Commission. Public advisory committees were established for the Buffalo Bay-Horse Lakes water management study and the Highwood River instream flow needs study. A public advisory committee was involved in the Cold Lake-Beaver River Water Management Study area. Most recently, partnerships have been promoted with public representatives on steering committees helping to direct programs rather than just providing input. This type of involvement has been used on some lake studies in Northern Alberta and is envisioned for the Peace-Athabasca-Slave Basin Study. Although public involvement is sometimes difficult and time consuming, it is an essential part of modern water resources planning.

The Changing Technology

The 1970s saw multiple-objective water resources planning become the framework for water resources planning. Planning technology took a major leap forward with the development of computer models simply because the business of predicting was accelerated enormously. Simulation and prediction models using a variety of mathematical relationships to describe the conditions in the real world have existed for many years. Examples include hydraulic, watershed (rainfall/runoff), and water-quality models. These models greatly increased their predictive capabilities as computer development has progressed in the last three decades.

For operational planning, a significant step forward came with the development of such things as microwave telephone and satellite communication. It became possible to provide models with up-to-date information about precipitation, water quantity and quality, allowing for more accuracy in such areas as flood forecasting and warning. Recently, major new advances have been made in the ability to monitor and detect pollutants at levels as minute as parts per trillion. This ability is currently producing large amounts of new information with a consequent challenge of storage, retrieval and use, as well as providing a major new opportunity to further protect the environment.

WATER RESOURCE PLANNING IN ALBERTA

Recent History

A number of major water resource planning exercises have been undertaken by Alberta Environment since 1975. Here are some details about two such examples:

- South Saskatchewan River Basin

After a large number of technical studies, an extensive planning program and recommendations resulting from public hearings held by the Water Resources Commission, a South Saskatchewan River Basin Water Management Policy was announced in May, 1990. This policy established an upper limit to irrigation expansion and started the instream flow process currently underway in the South Saskatchewan Basin.

- Cold Lake-Beaver River Basin

A planning program for this area was undertaken involving a number of technical studies, the examination of a number of water management alternatives, and extensive public involvement using public meetings, an advisory committee, and special meetings with stakeholders such as Indian Bands and local authorities. A water resources plan released in October, 1985 contained limits on withdrawals from local lakes, a ban of industrial surface water effluent discharges, and a commitment to develop water recycle guidelines for the in-situ oil sands industry. The water recycle guidelines were released in a joint Alberta Environment/Energy Resources Conservation Board Information Letter in May, 1989.

Planning studies have also been undertaken on the Oldman and Red Deer River Basins and are currently taking place in the North Saskatchewan River, Battle River, and Peace-Athabasca-Slave Rivers basins. They have also been undertaken on a number of lakes, wetland ares and reservoir sites.

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Scale

Four levels of scale are commonly used in water resources planning in Alberta: provincial, basin, sub-basin and site-specific.

A broad or provincial scale is the best context in which to set policies and guidelines for the whole province. The government's wetlands policy development which is being co-ordinated by the Water Resources Commission is an example of provincial scale policy development.

River basin planning looks at problems and opportunities faced in major basins ranging in size from the very large (South Saskatchewan) to the moderately small (Beaver River).

Water resources planning at small or "sub-basin scales" involving 500 to 1,000 square kilometres deals with water at the county and M.D. level that is catchment-based (i.e. boundaries defined by drainage catchment). The Buffalo Bay-Horse Lakes planning program at the west end of Lesser Slave Lake is one example of sub-basin planning.

Site and reach-specific planning is undertaken at a local level such as on a lake, at a major reservoir or for a reach of a particular river. Lesser Slave Lake and Cooking Lake are examples of site-specific planning.

Scope

Boundaries must also be established on issues to be examined in planning sites. Early water resource planning studies often focused on surface water quantity problems. However, the planners soon realized that groundwater and water quality had to be integral parts of the analysis. These items were early inclusions in Alberta Environment's water resource planning exercises since primary responsibility for them lay with the department.

Land use planning has a major impact on water resources. Opening land to agriculture, forest, harvesting and urbanization affects the quality and quantity of runoff. Land-use planning, however, is the primary responsibility of other agencies such as Alberta Forestry, Lands and Wildlife, local authorities and private landowners. Integration and co-ordination of land use and water planning is important because it is sometimes necessary to limit land uses to protect water uses and, likewise, to limit use of water resources to support some land-use activity.

Relationship to Other Planning Programs

Alongside Alberta Environment's water resources planning and/or management programs, other provincial departments and other levels of government carry on planning work that often has some influence on the province's water resources.

Local and regional authorities plan land uses which can directly and indirectly affect water bodies. Joint water resource planning exercises are the best way to address a number of local water resources problems. The pilot stage of the Northern Alberta Sub-basin Water Management Planning Program is an example of this type of partnership.

Provincial authorities undertake economic and public land-use planning that is related to water resources planning. Alberta Environment participates in the Integrated Resource Planning program co-ordinated by Alberta Forestry, Lands and Wildlife. Although primarily directed toward co-ordinating land-use planning on public lands

in the province, this program also provides an opportunity to co-ordinate policy on a broader range of items related to the environment.

Water resource planning and management is a provincial responsibility; however, the federal government has expressed an interest in joint water resources planning in Alberta as it has done in other provinces under the ***Canada Water Act***. At the same time, Alberta wishes to develop partnerships with other levels of government to assist it in meeting this responsibility. Alberta is evaluating the benefits of participation in the Canadian Heritage Rivers Program.

Relationship to Environmental Impact Assessments

Water resource planning always requires environmental information analysis and assessment. Occasionally, an Environmental Impact Assessment (EIA) process may initiate a planning exercise by recommending that the impacts of the project under review cannot be judged in isolation and that a basin-wide assessment is required. Typically, EIAs come after a water resources plan has been developed if the plan recommends a project. A completed planning program should reduce the number and complexity of EIAs required by systematically examining the important environmental factors prior to a particular project being proposed, or by establishing beforehand the limits within which projects must operate. Water resource planning and formal EIAs are tools that can be used together or separately to ensure that projects or activities are environmentally sustainable.

CURRENT LEGISLATION

The power to reserve unallocated water and analyze how it can best be used is provided in Section 12(1) of the ***Water Resources Act*** ; the general power to develop long term plans is provided in Section 7(k) of the ***Department of the Environment Act***. Formal water resources planning, however, is not spelled out in either Act. Planning has been used as a process to develop government policy and guidelines for a basin, region or project. Licencing and permit decisions have then been made on the basis of these government policies.

Issues, Future Direction, and Options

Planning is an important aspect of water management which has effectively been carried out in Alberta for some time. New policies and legislation may be required to deal with future water resource issues and management opportunities.

The importance of planning in modern water resource management suggests that it may deserve a more significant place in water resource policy and legislation. Formal water resource planning along with an approvals process and an amending process could be spelled out in the legislation. This would provide a stronger legal basis for planning. It could also be made into a statutory process similar to the land use planning process used at the municipal level. This would mean that any approvals given out by the department would, by law, have to conform with published water resource plans.

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QUESTIONS FOR DISCUSSION

- What is the role of the river basin planning process in water management decision-making? How can legislation help clarify this role?
- How should water management decisions be made in basins where the planning process has not started or is incomplete?
- What objectives or guidelines should be addressed in a river basin plan?

Some examples:

- The value of water as a sustainable resource.
- Surface and ground water withdrawal or effluent discharge limits.
- Instream water quality and quantity objectives or guidelines.
- Restrictions on land use activities which may have an impact on water resources.
- Water conservation and recycling guidelines or measures.
- Water management guidelines for emergency conditions such as droughts or floods.
- Other measures/policies/actions required for long term protection, improvement and wise use of the water resource.

- What should be the relationship of the integrated resource planning process to the river basin planning process?
- What relationship should other planning activities have with the river basin planning process?
- What information does the public need on the quantity and quality of surface and ground water?

WATER QUALITY/QUANTITY RELATIONSHIP

INTRODUCTION

Albertans use their water resource in a variety of ways; water uses can be considered in two broad categories, consumptive and non-consumptive uses. Consumptive uses include withdrawal of water from streams or wells for municipal, domestic, industrial and irrigation purposes. Non-consumptive uses withdraw little or no water from the surface or groundwater system and include maintenance of aquatic life and navigation, and pursuits such as domestic and commercial fishing, water skiing, swimming and aesthetic enjoyment. Another non-consumptive use is hydropower production. Each use, either consumptive or non-consumptive, requires that water of suitable quantity and quality be available at a particular location and at particular times or seasons.

Water resources planning and management must consider both the quantity and quality of the resource. The two characteristics of water are inextricably linked. Changes in the flow of a stream will affect the quality of the water in that stream and its ability to assimilate pollutants that enter the stream through both natural and human sources.

The purpose of this paper is to present information to stimulate public discussion and input on managing both the quality and quantity aspects of water in an efficient and co-ordinated manner.

THE RELATIONSHIP BETWEEN WATER QUANTITY AND QUALITY

Water quantity and quality are interrelated in both streams and lakes. Streams are dynamic; their flow rates and their water quality conditions are constantly changing. The relationships between quantity and quality in streams are complex and difficult to define; however, there are general characteristics of streams in Alberta that help to illustrate the interrelationship.

In Alberta, water quantity (discharge) in streams is usually highest following the snowmelt period or heavy rains in spring and early summer (see Figure 1). High flows erode stream banks and scour bottom sediments resulting in high concentrations of suspended solids. Because these solids have an affinity for metals and phosphorus, concentrations of particulate metals and phosphorus may also be higher during high discharge periods. Water clarity, light penetration and water temperature are generally low during the high runoff period, impairing growth of aquatic vegetation.

Since rain, snow and surface runoff are low in dissolved salts, our streams normally have reduced concentrations of dissolved salts during high runoff periods.

During mid to late summer when discharge decreases, water clarity and light penetration improve, temperature increases, and conditions for growth of aquatic vegetation improve. In late summer, fall and winter, groundwater

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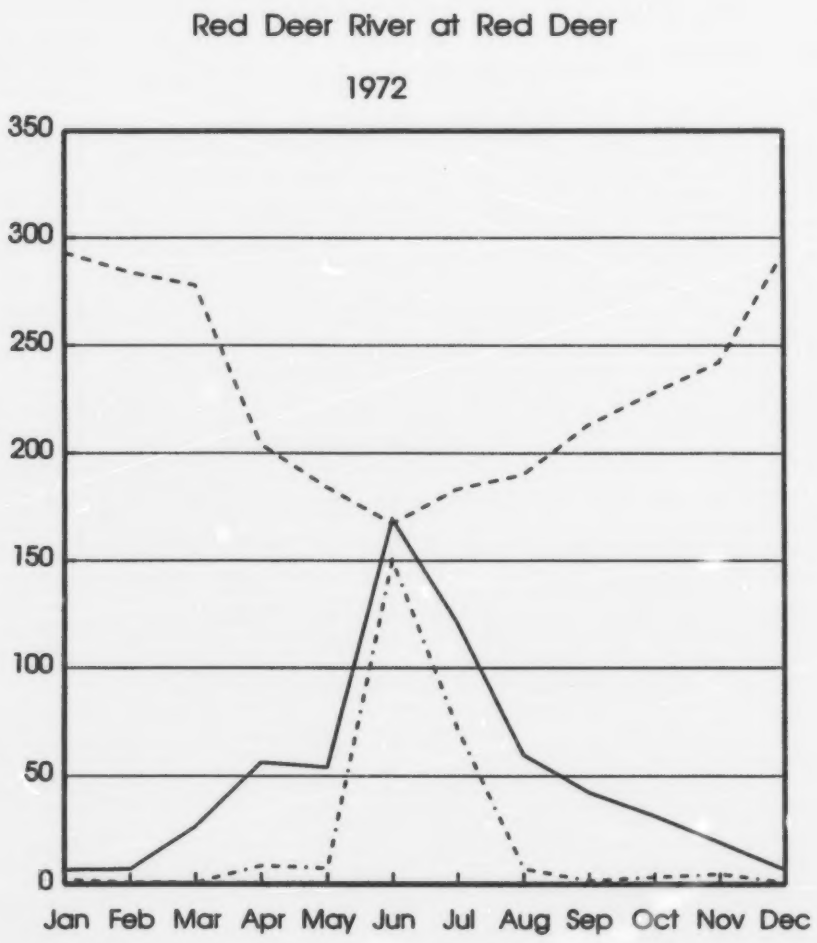
Figure 1: TYPICAL WATER/QUANTITY/QUALITY CHARACTERISTICS



_____ Discharge, m^3/s

- - - - - - Total Dissolved Solids, mg/l

____ . ____ Turbidity, Jackson Turbidity Units. (Turbidity and suspended solids are highly correlated in the Red Deer River.)

discharge to many streams makes up a higher proportion of the total flow of the stream. Since groundwater usually contains more dissolved salts than stream water, its relative greater contribution to the stream from late summer to winter results in higher concentrations of dissolved salts compared to spring and early summer.

In addition to sediments and other substances that enter our waterways through natural processes, we have a long history of disposing treated wastewater to our river systems. Most river systems have some capacity to assimilate wastes without adverse environmental effects, but that capacity is limited. The ability of streams to process organic and inorganic materials over a period of time is referred to as its assimilative capacity. If assimilative capacities are exceeded, adverse environmental impacts and impairment of other uses of the stream can be expected.

Rivers dilute the concentration of contaminating substances in wastewaters. The extent to which a contaminating substance is diluted is dependent upon the quantity and quality of the flow in the receiving stream. Rivers also have the capability to change the form and composition of some contaminants. These changes are the result of physical, chemical and biological processes that take place in the water such as settling, bacteriological decay, reaeration, biological uptake and chemical transformations. The extent to which a receiving stream will change a contaminant is flow-dependent. The key factors are water depth, velocity, and temperature. Water diversions from or uses in a stream reduce its capacity to dilute and assimilate wastes that enter downstream of the point of diversion or use.

Water quantity in lakes may affect water quality in many ways. Lake volume decreases when outflows exceed inflows. During the summer, evaporation from the lake surface is a major loss of water in many Alberta lakes, which often results in a decrease of lake volume. However, evaporation removes only water; the total mass of dissolved solids in the lake remains the same. Higher concentrations of dissolved solids (or increase in salinity) may affect the biological community; some freshwater species may not tolerate salinity fluctuations.

EXISTING PROCEDURES FOR ADDRESSING WATER QUANTITY AND QUALITY

LEGISLATION

Currently in Alberta, the ***Water Resources Act*** provides the legislative authority and procedures for managing water quantity. The ***Clean Water Act*** provides the primary legislative authority for preventing or controlling pollution of our surface water and fresh groundwater. Alberta Environment administers both Acts, each with its own controlling and enforcement mechanisms. The new ***Alberta Environmental Protection and Enhancement Act*** (AEPEA), currently in the drafting stage, incorporates the ***Clean Water Act.***

WATER RESOURCES PLANNING

Water resources planning is the development of plans that achieve the long-term protection, improvement and wise use of water on a provincial, river basin, regional or site-specific basis. Both the quality and quantity of the

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resource are considered. Development of river basin plans considers licences for water demand and effluent discharges, water quality and quantity monitoring data, and future development projections. There is no question of the need for and value of water resources planning: it provides a basis for decision-making within a river basin framework that considers long term impacts and the cumulative effects of independent projects.

The water resources planning process is outlined in more detail in the first paper in this Volume.

ANALYTICAL TOOLS

Alberta Environment has developed (or adapted) a number of water quantity and quality computer simulation models for water management planning and assessing impacts of development proposals in Alberta. Along with these analytical tools, data bases of known information on water quantity and quality are continually being developed, maintained and updated.

Selecting the appropriate water quantity and quality models for water management planning and impact assessments requires careful consideration of the issues being addressed, the resources and the data bases available, and the water quality variables of significance. Sophisticated water quality models that can simulate a large number of variables require a large data base for calibration and verification. Resources required to apply these models to specific water courses can be very costly. In some cases, use of simplified models may be more practical.

Water quantity and quality modelling must be integrated. Usually a water quantity model is used to predict the likely change in the flow regime of a watercourse or the storage regime in a lake or reservoir for a specific development or water management scenario. The output is then used in a water quality model to determine the water quality impact of the new flow or storage regimes. Anticipated future effluent loadings are put into the model. The results of the modelling are compared with water quality objectives for the watercourse, lake, or reservoir in order to determine the acceptability of the scenario. Usually this process is repeated numerous times to fully analyze a development or water management undertaking.

ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

The current and proposed processes for conducting environmental impact assessments on proposed developments provide mechanisms for addressing both water quantity and quality issues related to the projects under review. The environmental impact assessments, however, may not consider the cumulative impacts of several projects along a water course that may be developed over several decades.

Not all projects and activities affecting water quantity and quality have been subject to formal environmental impact assessments in the past. Under the proposed ***Alberta Environmental Protection and Enhancement Act***, formal environmental impact assessments will be mandatory for some projects; however, application of the environmental impact process on many projects and activities will be at the discretion of the Director or the Minister of Environment. The public will have input to the decision on whether or not a formal assessment is conducted.

More detail on the Environmental Impact Assessment process is provided in background paper Volume 9.

INSTREAM FLOW NEEDS

BACKGROUND

Instream Flow Needs are the stream flows required to provide for uses that depend directly or indirectly on water flowing in a stream. Such uses include habitat for fish, other aquatic organisms and wildlife; recreational uses, including those that take place in the water, such as swimming, boating and fishing, and those that take place adjacent to streams and are enhanced by stream flow, such as hiking, camping and picnicking; maintenance of aquatic and riparian ecosystems; maintenance and recharge of riparian water tables; and, in some cases, navigation. Instream uses commonly have quality as well as quantity dimensions, and particular levels of stream flow may be needed to maintain the water quality required to support those uses.

Water law and water policy in Western North America have focused on managing rivers and streams to meet the needs of uses that withdraw or impound water, such as irrigation, hydroelectric generation, and the municipal and domestic needs of urban centres. Instream flow needs have been less clearly understood, not well defined and in many instances not adequately provided for. This pattern of resource management which has been the practice in the prairie region of Western Canada has its roots in the legitimate measures taken by governments in the early years of this century to encourage the settlement and development of the region. As had been the practice in the settlement of the western U.S.A., those measures included making water easily available to support agriculture and industry. In recent times, as our rivers and streams have become more heavily used and irrigation demands have grown, the needs of instream uses became apparent. These needs were particularly evident during the drought years of the past decade. However, as recreation and tourism have become more important elements of the North American economy, and as society has become more environmentally conscious, measures have been introduced to establish a better balance between withdrawal uses and instream uses.

Beginning with Montana in 1969, most western U.S. states have introduced laws intended to provide some degree of protection for instream flows. These laws vary in the uses they protect, in the means by which the protection is provided, and in who may obtain protection. For example, in Montana flow can be earmarked for a variety of uses, but the reservation can only be obtained by a state agency, and it is subject to review every 10 years. This affords instream flow less security than that available for other licensed uses.

In Alaska, by contrast, any citizen or any public or private entity can obtain an appropriation for the use of water for instream uses. There are few such rights to water for instream uses in any of the western Canadian provinces, and strong arguments have been put forward for an effective way of enacting such rights.

In Alberta, in the early 1980s the South Saskatchewan River Basin Planning Program focused attention on the existing and potential conflicts between instream flow needs, and the withdrawal and waste disposal uses that predominate in rivers in that basin. The instream flow needs used in this program were determined through a modified application of the Instream Flow Incremental Methodology (IFIM) developed by the Instream Flow Service Group in Fort Collins, Colorado, U.S.A. The modifications to the methodology were necessary because the biological and hydrological data bases were incomplete. The IFIM, as currently applied with improved data bases, is a substantial improvement over these first crude methods for estimating fish flow requirements formerly applied in licensing procedures.

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In 1986, the Alberta Water Resources Commission released their Report and Recommendations on Water management in the South Saskatchewan River Basin. The Commission's conclusions, based on public hearings held throughout the South Saskatchewan River Basin during 1984, led to a number of recommendations pertaining to instream uses of rivers in the basin. In summary, the Commission recommended that to be consistent with the philosophy of multi-purpose use, instream flow amounts should be established on a reach-by-reach basis for all major river reaches and tributaries in the basin. They further recommended that minimum flow amounts should be established to protect water quality and to prevent fish kills, and that in regulated streams, flow should only be reduced to the minimum for short periods during times of extremely low flow resulting from climatic conditions.

POLICY

In May of 1990, the Minister of Environment released a government water management policy statement for the South Saskatchewan River Basin. This policy statement, based on the recommendations of the Alberta Water Resources Commission, clarifies the government's position on instream flow needs. The policy statement confirms that all rights to divert and use water granted in the form of licences issued under the ***Water Resources Act*** , and their relative priority as established by the date of application for the right, will be respected. While the policy does not contemplate the licensing of instream flows, it notes that consideration must be given to the need to retain water in the river for instream needs, including recreation, fisheries, wildlife, and the ecology of the river. It specifies that two levels of instream flow will be established for reaches of rivers in the basin: preferred instream flow and minimum instream flow. When the sum of the licensed allocations and the instream flow allocations for a river reach a predetermined level, the remaining flow of the river will be reserved under the terms of the ***Water Resources Act*** , and further allocations of water will be based on a system of preferential use. The policy requires that rivers will be managed to meet preferred instream flows most of the time, but, if under drought conditions existing licensees would experience water shortages, instream flows will be allowed to drop to minimum levels for short periods of time.

APPLICATION

In mid-1989, the Alberta government established the first of a set of inter-agency basin working groups who are to work closely with members of the public to implement the instream flow needs policy on rivers in the South Saskatchewan River Basin. At the local and regional levels, river basin working groups were formed to work in consultation with special interest groups and the general public to recommend the preferred and minimum stream flow needed to satisfy the requirements of instream uses.

In this process, the public includes persons with a direct stake in the river, such as riparian landowners and existing licensees, organized groups that represent special interests, such as fishing, recreation or irrigation, and persons with a general interest in environmental protection and resource management. Public meetings are held and public advisory committees formed, to provide the public with opportunities to contribute to the determination of IFN.

A number of different methodologies may be employed in an analytical process to determine Instream Flow Needs. First, the amounts and patterns of stream flow required to meet both the preferred and minimum needs of the identified uses must be identified. Second, these flows must be developed into composite values that can be recommended as the instream flow to be established for the river reaches in question. Generally speaking, instream flow needs are scientifically-based criteria defining the flow that must exist to provide the best (preferred) conditions and the bare survival (minimum) conditions for specific uses.

Instream flow needs are frequently established as the basis for a water management plan for the river. In these cases, the recommended instream flow will be established in a form that is implementable given the currently

affordable means for monitoring and managing stream flow and water quality conditions in the river. Similarly, a plan for the management of a river must include advice as to the monitoring and management means that will be required to ensure that the instream flow needs can be satisfied.

The process for establishing instream flows has, as of July, 1991, been applied to five streams: the Highwood, Willow Creek, and the Belly, St. Mary and Waterton Rivers, referred to as the three southern tributaries of the Oldman River.

In the case of the Highwood, the instream flow needs have been determined and recommended for establishment, and a plan for managing the river to meet the instream flow needs in a manner consistent with the South Saskatchewan River Basin Policy has been developed. Because of the importance of the Highwood River system as the principal spawning area for the internationally known rainbow trout that inhabit the Bow River, the instream flow needs determination focused primarily on the maintenance of fish habitat. The determination of the instream flow needs and the development of a management plan for the Highwood River was complicated by the need to coincidentally devise a plan for diverting water from the Highwood River to the Little Bow Project. Partly because of this association with the Little Bow Project, the recommended Highwood instream flow needs and the management plan are currently the subject of a formal Environmental Impact Assessment.

Work toward the recommendation of the instream flow needs of Willow Creek and the Belly, St. Mary and Waterton Rivers is still underway. A process leading to the establishment of instream flow needs for the Red Deer River is slated for implementation in 1991.

ISSUES

Some of the difficulties that have been encountered in the implementation of this process, and which have limited its application to the rivers noted, include the lack of information required to define the needs of some uses, limited resources for collecting data and undertaking the research and analysis required to provide the required information, and the time, communication mechanisms, and logistical arrangements required to effectively involve special interest groups and the general public in the process.

Many issues have been raised during the course of implementing the process for establishing instream flow needs. There have been concerns about the methodologies used to determine flow needs, about the application of the process to heavily allocated streams, about the means that have been employed to obtain public involvement in the process, and about the effectiveness of the process itself for achieving the objective of protecting instream water uses. However, by far the most prominent issue is the question of how instream flows, once established, can be protected on an equal basis with licensed uses.

QUESTIONS

The following are questions that need to be considered:

a) What rivers or reaches of rivers should be assigned a high priority for the establishment of Instream Flow Needs?

b) What level of risk to the maintenance of instream needs and withdrawal uses should be considered in establishing Instream Flow Needs?

c) Should a stream's capacity to assimilate waste be considered as an independent use in establishing Instream Flow Needs?

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d) How could the public be most effectively involved in the establishment of Instream Flow Needs?

e) How can Instream Flow Needs, once established, best be protected – through licensing or some other mechanism?

LAKE MANAGEMENT

INTRODUCTION

Alberta is fortunate to have a wide diversity of lakes, ranging from the large brown water lakes in the boreal forest, to the green shallow lakes of the prairies, to the clear lakes with sandy beaches of the lakeland area. In their natural state, these lakes provide for many uses and support a variety of aquatic plants, fish, and wildlife. The experience of cottaging, boating, camping and fishing at the lake has a long history in Canada. The goal of lake management is to ensure that these experiences will be preserved for future generations.

BACKGROUND

Lake Levels

Water levels in Alberta lakes are constantly fluctuating. They change from season to season and year to year. Most changes in lake levels are natural and caused by climatic factors such as precipitation (snowfall and rainfall) and evaporation. Lake levels usually are highest in the spring due to runoff from snowmelt and then gradually drop through the summer and fall. Outflow from a lake can be another important water level factor, but usually more is lost due to evaporation.

Fluctuating lake levels are a natural occurrence. As shoreline vegetation is alternatively flooded and exposed, new growth replaces old growth. This cycle results in a healthy ecosystem. Some shorebirds such as killdeer and sandpiper depend on lake level fluctuations to expose shorelines for feeding and nesting.

Significant variability in lake levels represents a problem for some lake users. High lake levels often result in flooding and increased shoreline erosion, and make boat docks and beach areas unusable. Unsightly mud flats resulting from low levels are another concern to lake users.

Water Quality

The term "water quality" means different things to different people. It encompasses negative aesthetic qualities such as weed and algal growth, clarity and odour, as well as human health concerns such as the presence of fecal coliform bacteria and the traditional chemical characteristics such as hardness, salinity and nutrients.

A major concern in many Alberta lakes is the trophic status. The trophic status, sometimes called the nutrient status, of a lake is a measure of the level of nutrients in a lake. Many of Alberta's prairie lakes are not very suitable for recreational activities because they are eutrophic or hypereutrophic. This means they have high or very high levels of nutrients. As a result they are often murky, green, choked with aquatic plants, and dominated by warm water fish such as suckers, perch, pike and minnows. Many of these lakes, however, are ideal for waterfowl. Often people think that the degree of eutrophication can be controlled through human intervention. However, most lakes are naturally eutrophic and, outside of massive chemical intervention, little can be done to

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change them in this respect. At the other end of the trophic status scale are oligotrophic lakes that are very low in nutrients and are usually clear, free of weed growth and support fewer fish. These lakes are usually found in the mountains or foothill regions. Mesotrophic lakes, in between these extremes, are often regarded as the best recreation lakes.

Human Activities

Albertans make extensive use of the province's lakes. Information from a survey conducted in 1988 indicates that 70 percent of Alberta households participated in some form of water-based recreation, including fishing, boating, and swimming.

Most of this activity occurred at campgrounds and day-use areas. A recent survey of 100 Alberta lakes determined that campground facilities had been developed at 77 of them. The majority of provincial parks and recreation areas (about 80 percent) are also located adjacent to lakes, and surveys indicate that 50.4 percent of park visitors participated in one or more water-based activities.

Many Albertans own cottages at various lakes within the province. According to a 1988 study, there were about 20,000 developed cottages in Alberta, and about 40 percent of these were located on just five lakes: Pigeon, Lac Ste. Anne, Wabamun, Sylvan, and Gull lakes. Surveys also indicate there is considerable interest in new cottage developments. Lake lots are preferred by about 68 percent of potential new cottage buyers.

Non-Albertans also make use of Alberta's lakes. The 1982 Alberta Travel Survey indicates that 12 percent of visitors to Alberta went swimming, 6 percent went fishing and 3 percent went canoeing during their visit.

Thus, recreational use of lakes in Alberta is significant and is expected to increase. Such increases will mean more extensive demands for tourist and recreational facilities around lakes. Humans affect lakes in a variety of ways. Shoreline developments, such as docks and erosion protection, boating, waterskiing, swimming, hunting and fishing, all have some impact on lakes and their ecosystems. Lakes can sustain a certain level of activity, but overuse is always a potential problem.

As noted previously, the trophic status of lakes depends on the supply of nutrients entering the lake from surrounding soils, the lake bottom, and the atmosphere. Human activities including agriculture, forest clearing, improper sewage disposal, and runoff from recreational properties may have an impact on a lake. Fertilizers, nutrients intended to enrich the soil, often are not totally consumed by crops, and are carried by snowmelt and rainfall into lakes. This process enriches the lake and it becomes more eutrophic.

Another concern in some lakes is the existence of fecal coliform bacteria that can result from poorly functioning residential sewage facilities. Local health units regularly conduct water quality sampling in heavily-used swimming areas to ensure that people's health is not put at risk.

More background information on Alberta's lakes can be found in the recently published Atlas of Alberta's Lakes.

LAKE MANAGEMENT ACTIVITIES

In general, there are two forms of lake management: indirect lake management such as control of shoreland use or controls/limits upon fishing, and active lake management such as regulation of lake level or chemical weed control.

Indirect Lake Management

Indirect lake management activities are the controls used to limit human impacts on lakes. These include limits on access, controls on development, restrictions on agricultural activities, forest clearing, sewage controls and limits on fishing, boating and hunting. This type of management protects the aquatic environment.

Land Use

Controls on lake shore development of privately owned lands are usually carried on through the land-planning process co-ordinated by Alberta Municipal Affairs and the Regional Planning Commissions. These planning exercises and resulting by-laws limit the type of development, outline which areas can be developed, and also provide general development guidelines.

Many lakes are surrounded by public lands. These lands, controlled by Alberta Forestry, Lands and Wildlife, can be put to only a limited number of uses and are controlled through a permit process. Timber harvesting, grazing leases, oil and gas, and mineral extraction are the common uses.

Shoreline development controls are carried out by Alberta Environment and other agencies. Erosion control structures, permanent docks and other activities which may have an impact on shorelines require permits under the ***Water Resources Act***.

Sewage

Effluent from private sewage facilities is often a major concern around lakes. Private sewage disposal in Alberta is governed by two statutes; the ***Plumbing and Drainage Act*** and the ***Public Health Act*** . Alberta Environment has limited responsibilities through the ***Clean Water Act*** . To clarify roles and responsibilities, two agreements have been signed, one between Alberta Environment and Alberta Labour, and one between Alberta Labour and Alberta Health. These agreements ensure that responsibilities for handling complaints, undertaking inspections, and issuing permits are understood by everyone involved. These agreements work well where one private sewage disposal system is functioning very poorly or not at all. Concern, however, has arisen when a number of individual older sewage disposal systems are functioning reasonably well but the cumulative impacts may be damaging lakes.

In Manitoba and Ontario, private sewage systems are regulated entirely by the Departments of the Environment. Private sewage systems in these jurisdictions may be looked upon as subjects of environmental concern, while in Alberta they are viewed primarily as a construction concern and are treated as such by the Department of Labour.

Pesticides

Alberta Environment, under the authority of the ***Agricultural Chemicals Act*** , restricts the use of pesticides within 30 metres of open bodies of water. However, permits are issued by the Pesticide Management Branch for pesticide applications within 30 metres, or directly to open bodies of water for some specific uses such as: mosquito control, aquatic vegetation control, control of restricted and noxious weeds along riparian habitat (***Weed Control Act***), and control of forest tent caterpillars at summer villages, etc. Pesticides permitted for use under these situations are selected for favourable environmental and toxicological characteristics. Application of pesticides within 30 metres of an open body of water without a permit can lead to enforcement action.

Active Lake Management

Active lake management involves actions that directly affect or alter a lake to meet some need, usually a human need. Such activities are usually designed to control water levels and/or to "enhance" the water quality of a lake

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or to return it to a natural condition. Activities under this category include: weirs, pumping and diversions, outlet channel alterations, mechanical weed control and the use of chemicals to control algal plant growth.

Weirs

To stabilize or regulate lake levels or control outflows, weirs are often constructed at lake outlet. They are usually designed to allow more water to flow out when the level is high and less when low. This arrangement reduces fluctuations in the lake level. Weirs may also be built to compensate for withdrawals, assuring no major reductions in levels.

The control of fluctuation achieved by a weir is often very limited, especially on large lakes with small outflows. Changing the outflow conditions of a lake may result in problems downstream where other users are affected, and it may be difficult for cottage owners and other users to arrive at a consensus with respect to preferred water levels. In addition, stabilizing water levels can increase aquatic plant growth around a lake.

Pumping and Diversion

To add water to a lake, creeks that normally do not drain into it can be diverted or water can be pumped from a nearby waterbody or aquifer. However, such efforts often result in merely moving the problem of low levels from one waterbody to another. Each waterbody is a unique ecological system, and therefore there is the potential to move fish species or fish diseases from one basin to another through such schemes, perhaps causing severe ecological damage. This type of problem is referred to by the scientific name "transfaunation". As well, each lake has its own chemical characteristics and transferring water when the source water has much different chemistry than the target lake can cause problems.

Outlet Channel Alterations

To limit flooding around a lake, the outlet channel can be increased or cleared of obstructions such as weed growth. While more water can then pass downstream, especially when the lake level is high, the flooding problem may be transferred downstream. Occasionally, beaver activity in outlet creeks may also affect lake levels. Beaver control measures are undertaken by the provincial government and local authorities.

Mechanical Aquatic Plant Control

Mechanical control techniques used to remove aquatic plants from lakes include dragging, cutting, harvesting, rotovating (i.e., sediment tillage) and suction. The advantage of mechanical control (as opposed to chemical control) is that the results are immediate and potential environmental impacts are minimized.

Unless root systems and plant debris are removed from the water after displacement, regrowth and re-establishment of the plants will occur. Uncollected plant fragments will decay, re-introducing nutrients to the water. They can also clog intakes and other structures. Frequently, because mechanical techniques provide only short-term control of localized problems, multiple treatments are required in a season.

When considering any aquatic plant control activity, the benefit of control should be weighed against the loss of benefits that aquatic plants provide. These plants provide oxygen and erosion-protection to lakes as well as food, shelter, nesting areas, and spawning areas to lake inhabitants. Careful selection of control areas and minimizing the amount of control will limit impact on lake environment.

Use of Chemicals to Control Algal Plant Growth

A variety of chemicals including alum, fly ash, and copper sulphate have been used in an attempt to control the growth of algae in lakes, dugouts, stormwater ponds, and irrigation canals. These efforts have met with varying success but may have negative environmental impacts.

Lime (either calcium carbonate or calcium hydroxide) has been used on an experimental basis in a few small Alberta lakes. The objective of a lime treatment is to transfer phosphorous from lake water to bottom sediments.

Since phosphorus is usually the nutrient that determines the volume of algal growth, removal of phosphorus from lake water could reduce algal growth. Short-term improvement in water clarity has been observed following treatment, a characteristic which may be beneficial to recreational lake users. However, lime may negatively affect other components of the lake ecosystem (fish, zooplankton, bacteria, etc.), and long-term positive or negative environmental impacts of lime treatment are unknown.

Experience in the United States has shown that these lake restoration techniques are worthwhile only where there are existing inputs from human activities and where these inputs can be redirected. In such cases, chemical restoration techniques can be used to speed up recovery of a lake. These restoration efforts also show that before any restoration technique is undertaken, a good scientific understanding of each lake's ecosystem is required.

ISSUES, FUTURE DIRECTION AND QUESTIONS FOR DISCUSSION

Indirect Versus Active Lake Management

In many other jurisdictions and in the scientific literature, the philosophy of water management has been shifting from active management to more use of indirect management techniques; from structural solutions to non-structural solutions. In lakes, this translates into less reliance on weirs, pumping and trying to control problems chemically (i.e. problem solving) and shifts the balance to include more emphasis on land-use controls, better sewage treatment, and minimizing agricultural runoff (i.e. problem prevention).

This change in philosophy has meant encouraging recreational users of lakes to accept natural variations in the conditions of lakes. It has also meant encouraging land use and water resource planners and users to give protection of lake water resources a high level of importance.

- What should be the balance between active lake management and indirect lake management?

Land Use Activities and Planning Around Lakes

The planning of land use activities around lakes is not undertaken in a comprehensive fashion. Crown land is administered separately from private land. Local authorities have basic control over private land development but are assisted in this task by the Department of Municipal Affairs and the Regional Planning Commissions. Some believe that Alberta Environment should be given some responsibility and authority to protect lake water from the various land use activities, especially sewage disposal practices. Use of pesticides and fertilizers also concern many people who use lakes. Although controls are thought to be adequate for land which borders lakes, small tributary creeks and drainage systems may carry these chemicals to a lake. Some lakes are more susceptible to eutrophication from agricultural runoff, and controls specific to their basins may be needed.

Forestry activities can have a significant impact on lakes, and concern grows as forestry development shifts from the foothills area to the mixed-wood boreal area where many of the most popular recreational lakes are found. The Alberta Forest Service, through its Forest Management Agreements, exercises controls to protect lakes.

- What agencies should be responsible for land use planning around lakes?

- Should Alberta Environment take some responsibility for private sewage treatment guidelines around lakes?

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- Should lake planning recommend special controls on pesticides, fertilizers and other intensive agricultural operations (such as feedlots) around lakes, where warranted?

- How should forestry planning account for concerns regarding lake protection? How or should Alberta Environment be involved?

- Should there be changes in how shoreline developments are controlled?